



Facts About Dietary Supplements

Clinical Nutrition Service, Warren Grant Magnuson Clinical Center • Office of Dietary Supplements •
National Institutes of Health

Vitamin D

As a consumer, you need information you can trust to help you make thoughtful decisions about eating a healthful diet and using vitamin and mineral supplements. Registered dietitians at the Warren Grant Magnuson Clinical Center, the clinical research hospital at the National Institutes of Health (NIH) in Bethesda, MD, developed this series of Fact Sheets in conjunction with the Office of Dietary Supplements in the Office of the Director of NIH to provide responsible information about the role of vitamins and minerals in health and disease and to help guide your decisions on the use of vitamin and mineral supplements. Each fact sheet in this series received extensive scientific review by recognized experts from the academic and research communities. The information is not intended to be a substitute for professional medical advice. It is important that you seek the advice of a physician about any medical condition or symptom. It is also important to seek the advice of a physician, registered dietitian, pharmacist, or other qualified health care professional about the appropriateness of taking dietary supplements and their potential interactions with medications.

Vitamin D: What is it?

Vitamin D, calciferol, is a fat-soluble vitamin. It is found in food, but also can be made in your body after exposure to ultraviolet rays from the sun (1,2). Vitamin D exists in several forms, each with a different activity. Some forms are relatively inactive in the body, and have limited ability to function as a vitamin. The liver and kidney help convert vitamin D to its active hormone form. (3).

The major biologic function of vitamin D is to maintain normal blood levels of calcium and phosphorus (4). Vitamin D aids in the absorption of calcium, helping to form and maintain strong bones. It promotes bone mineralization in concert with a number of other vitamins, minerals, and hormones. Without vitamin D, bones can become thin, brittle, soft, or misshapen. Vitamin D prevents rickets in children and osteomalacia in adults, which are skeletal diseases that result in defects that weaken bones (5,6).

What are the sources of vitamin D?

Food sources

Fortified foods are the major dietary sources of vitamin D (4). Prior to the fortification of milk products in the 1930s, rickets (a bone disease seen in children) was a major public health problem in the United States. Milk in the United States is fortified with 10 micrograms (400 IU) of vitamin D per quart, and rickets is now uncommon in the US (7).

One cup of vitamin D fortified milk supplies about one-fourth of the estimated daily need for this vitamin for adults. Although milk is fortified with vitamin D, dairy products made from milk such as cheese, yogurt, and ice cream are generally not fortified with vitamin D. Only a few

foods naturally contain significant amounts of vitamin D, including fatty fish and fish oils (4). The table of selected food sources of vitamin D suggests dietary sources of vitamin D.

Exposure to sunlight

Exposure to sunlight is an important source of vitamin D. Ultraviolet (UV) rays from sunlight trigger vitamin D synthesis in the skin (7,8). Season, latitude, time of day, cloud cover, smog, and sunscreens affect UV ray exposure (8). For example, in Boston the average amount of sunlight is insufficient to produce significant vitamin D synthesis in the skin from November through February. Sunscreens with a sun protection factor of 8 or greater will block UV rays that produce vitamin D, but it is still important to routinely use sunscreen whenever sun exposure is longer than 10 to 15 minutes. It is especially important for individuals with limited sun exposure to include good sources of vitamin D in their diet.

Is there a Recommended Dietary Allowance for vitamin D for adults?

The Recommended Dietary Allowance (RDA) is the average daily dietary intake level that is sufficient to meet the nutrient requirements of nearly all (97-98%) healthy individuals in each life-stage and gender group (4). There is insufficient evidence to establish a RDA for vitamin D. Instead, an Adequate Intake (AI), a level of intake sufficient to maintain healthy blood levels of an active form of vitamin D, has been established. The 1998 AIs (4) for vitamin D for adults, in micrograms (mcg) and International Units (IUs) are:

Life Stage	Men	Women
Ages 19-50	5 mcg* or 200 IU	5 mcg* or 200 IU
Ages 51-69	10 mcg* or 400 IU	10 mcg* or 400 IU
Ages 70+	15 mcg* or 600 IU	15 mcg* or 600 IU
*1 mcg vitamin D = 40 International Units (IU)		

Estimates of vitamin D intake in the United States are not available because dietary surveys do not assess vitamin D intake. Dietary intake of vitamin D is largely determined by the intake of fortified food (4).

When can vitamin D deficiency occur?

A deficiency of vitamin D can occur when dietary intake of vitamin D is inadequate, when there is limited exposure to sunlight, when the kidney cannot convert vitamin D to its active form, or when someone cannot adequately absorb vitamin D from the gastrointestinal tract (7).

The classic vitamin D deficiency diseases are rickets and osteomalacia. In children, vitamin D deficiency causes rickets, which results in skeletal deformities. In adults, vitamin D deficiency can lead to osteomalacia, which results in muscular weakness in addition to weak bones (5,6,7).

Who may need extra vitamin D to prevent a deficiency?

Older Americans (greater than age 50) are thought to have a higher risk of developing vitamin D deficiency(9). The ability of skin to convert vitamin D to its active form decreases as we age (4, 10-12). The kidneys, which help convert vitamin D to its active form, sometimes do not work as well when people age. Therefore, some older Americans may need vitamin D from a supplement.

It is important for individuals with limited sun exposure to include good sources of vitamin D in their diets (8, 13-15). Homebound individuals, people living in northern latitudes such as in New England and Alaska, women who cover their body for religious reasons, and individuals.

working in occupations that prevent exposure to sunlight are at risk of a vitamin D deficiency. If these individuals are unable to meet their daily dietary need for vitamin D, they may need a supplement of vitamin D.

Individuals who have reduced ability to absorb dietary fat (fat malabsorption) may need extra vitamin D because it is a fat soluble vitamin. Some causes of fat malabsorption are pancreatic enzyme deficiency, Crohn's disease, cystic fibrosis, sprue, liver disease, surgical removal of part or all of the stomach, and small bowel disease (6). Symptoms of fat malabsorption include diarrhea and greasy stools (16).

Vitamin D supplements are often recommended for exclusively breast-fed infants because human milk may not contain adequate vitamin D (17-20). The Institute of Medicine states that "With habitual small doses of sunshine breast- or formula-fed infants do not require supplemental vitamin D." Mothers of infants who are exclusively breastfed and have a limited sun exposure should consult with a pediatrician on this issue. Since infant formulas are routinely fortified with vitamin D, formula fed infants usually have adequate dietary intake of vitamin D.

What are some current issues and controversies about vitamin D?

Vitamin D and osteoporosis

It is estimated that over 25 million adults in the United States have, or are at risk of developing osteoporosis (21). Osteoporosis is a disease characterized by fragile bones. It results in increased risk of bone fractures. Having normal storage levels of vitamin D in your body helps keep your bones strong and may help prevent osteoporosis in elderly, non-ambulatory individuals, in post-menopausal women, and in individuals on chronic steroid therapy.

Researchers know that normal bone is constantly being remodeled (broken down and rebuilt). During menopause, the balance between these two systems is upset, resulting in more bone being broken down (resorbed) than rebuilt. Estrogen replacement, which limits symptoms of menopause, can help slow down the development of osteoporosis by stimulating the activity of cells that rebuild bone.

Vitamin D deficiency, which occurs more often in post-menopausal women and older Americans (4,9,10-12), has been associated with greater incidence of hip fractures (22). A greater vitamin D intake from diet and supplements has been associated with less bone loss in older women (23). Since bone loss increases the risk of fractures, vitamin D supplementation may help prevent fractures resulting from osteoporosis.

In a group of women with osteoporosis hospitalized for hip fractures, 50 percent were found to have signs of vitamin D deficiency. Treatment of vitamin D deficiency (22) can result in decreased incidence of hip fractures, and daily supplementation with 20 mcg (800 IU) of vitamin D may reduce the risk of osteoporotic fractures in elderly populations with low blood levels of vitamin D. (24) Your physician will discuss your need for vitamin D supplementation as part of an overall plan to prevent and/or treat osteoporosis when indicated.

Vitamin D and cancer

Laboratory, animal, and epidemiologic evidence suggest that vitamin D may be protective against some cancers. Some dietary surveys have associated increased intake of dairy foods with decreased incidence of colon cancer (25-27). Another dietary survey associated a higher calcium and vitamin D intake with a lower incidence of colon cancer (28). Well-designed clinical trials need to be conducted to determine whether vitamin D deficiency increases cancer risk, or if an increased intake of vitamin D is protective against some cancers. Until such trials are conducted, it is premature to advise anyone to take vitamin D supplements to prevent cancer.

Vitamin D and steroids

Corticosteroid medications are often prescribed to reduce inflammation from a variety of medical problems. These medicines may be essential for a person's medical treatment, but they have potential side effects, including decreased calcium absorption (29,30). There is some evidence that steroids may also impair vitamin D metabolism, further contributing to the loss of bone and development of osteoporosis associated with steroid medications (30). For these reasons, individuals on chronic steroid therapy should consult with their physician or registered dietitian about the need to increase vitamin D intake through diet and/or dietary supplements.

Vitamin D and Alzheimer's Disease

Adults with Alzheimer's disease have increased risk of hip fractures (31). This may be because many Alzheimer's patients are homebound, and frequently sunlight deprived. Alzheimer's disease is more prevalent in older populations, so the fact that the ability of skin to convert vitamin D to its active form decreases as we age also may contribute to increased risk of hip fractures in this group (4,10-12). One study of women with Alzheimer's disease found that decreased bone mineral density was associated with a low intake of vitamin D and inadequate sunlight exposure (32). Physicians evaluate the need for vitamin D supplementation as part of an overall treatment plan for adults with Alzheimer's disease.

What is the health risk of too much vitamin D?

There is a high health risk associated with consuming too much vitamin D (33). Vitamin D toxicity can cause nausea, vomiting, poor appetite, constipation, weakness, and weight loss (34). It can also raise blood levels of calcium, causing mental status changes such as confusion. High blood levels of calcium also can cause heart rhythm abnormalities. Calcinosi, the deposition of calcium and phosphate in soft tissues like the kidney can be caused by vitamin D toxicity (4).

Consuming too much vitamin D through diet alone is not likely unless you routinely consume large amounts of cod liver oil. It is much more likely to occur from high intakes of vitamin D in supplements. The Food and Nutrition Board of the Institute of Medicine considers an intake of 25 mcg (1,000 IU) for infants up to 12 months of age and 50 mcg (2,000 IU) for children, adults, pregnant, and lactating women to be the tolerable upper intake level (UL). A daily intake above the UL increases the risk of adverse health effects and is not advised.

Selected Food Sources of Vitamin D (4, 36, 37)

As the 2000 Dietary Guidelines for Americans state, "Different foods contain different nutrients. No single food can supply all the nutrients in the amounts you need" (35). The following table suggests dietary sources of vitamin D. As the table indicates, fortified foods are a major source of vitamin D. Breakfast cereals, pastries, breads, crackers, cereal grain bars and other foods may be fortified with 10% to 15% of the DV for vitamin D. It is important to read the nutrition facts panel of the food label to determine whether a food provides vitamin D.

If you want more information about building a healthful diet, refer to the Dietary Guidelines for Americans and the Food Guide Pyramid.

Table of Selected Food Sources of Vitamin D

<i>Food</i>	<i>International Units</i>	<i>%DV*</i>
Cod Liver Oil, 1 Tbs.	1,360 IU	340
Salmon, cooked, 3 1/2 oz	360 IU	90
Mackerel, cooked, 3 1/2 oz	345 IU	90
Sardines, canned in oil, drained, 3 1/2 oz	270 IU	70
Eel, cooked, 3 1/2 oz	200 IU	50
Milk, nonfat, reduced fat, and whole, vitamin D fortified, 1 c	98 IU	25
Cereal grain bars, fortified w/ 10% of the DV, 1 each	50 IU	10
Pudding, 1/2 c prepared from mix and made with vitamin D fortified milk	50 IU	10

Table of Selected Food Sources of Vitamin D

<i>Food</i>	<i>International Units</i>	<i>%DV*</i>
Dry cereal, Vit D fortified w/10%* of DV, 3/4 c * Other cereals may be fortified with more or less vitamin D	40-50 IU	10
Liver, beef, cooked, 3 1/2 oz	30 IU	8
Egg, 1 whole (vitamin D is present in the yolk)	25 IU	6

* DV = Daily Value. DVs are reference numbers based on the Recommended Dietary Allowance (RDA). They were developed to help consumers determine if a food contains very much of a specific nutrient. The DV for vitamin D is 400 IU. The percent DV (%DV) listed on the nutrition facts panel of food labels tells adults what percentage of the DV is provided by one serving. Percent DVs are based on a 2,000-calorie diet. Your Daily Values may be higher or lower depending on your calorie needs. Foods that provide lower percentages of the DV will contribute to a healthful diet.

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